PB83-131128

Aquatic Animals as Indicators of Environmental Exposures

(U.S.) Environmental Protection Agency
Gulf Breeze, FL

1982

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before comple

1. REPORT NO.	2.	3
EPA-600/J-82-242	Journal Article	PB83-131128

4. TITLE AND SUBTITLE	5. REPORT DATE
AQUATIC ANIMALS AS INDICATORS OF ENVIRONMENTAL EXPOSURES	1982
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
John A. Couch	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
	X6NL20
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
U.S. Environmental Protection Agency Office of Research and Development Environmental Research Laboratory Gulf Breeze, Florida 32561	14. SPONSORING AGENCY CODE EPA/600/04

15. SUPPLEMENTARY NOTES
Ref: J. Environ. Sci. Health A17(4) 473-476 (1982)

16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
DISTRIBUTE TO PUBLIC	UNCLASSIFIED	4
	20. SECURITY CLASS (This page)	22. PRICE
	UNCLASSIFIED	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

EPA-600/J-82-242
JOURNAL ARTICLE

J. ENVIRON. SCI. HEALTH, A17(4), 473-476 (1982)

AQUATIC ANIMALS AS INDICATORS OF ENVIRONMENTAL EXPOSURES

KEY WORDS: Environmental exposures, aquatic animals, wildlife surrogates, carcinogens, exposure models, sentinels, indicators

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ABSTRACT

Aquatic animals are useful as indicators of many kinds of pollutants in the aquatic environment. The presence of pollutants in the general environments of air, land, and water is reflected in their accumulations in and effects on aquatic organisms because the aquatic portion of the biosphere is often the "sink" for human-generated pollutants. Aquatic animals lend themselves particularly well to the study of special phenomena, such as carcinogenesis and teratogenesis. The use of aquatic animals and systems adds an important dimension to research on those pollutants that may affect wildlife and human health.

Because of intimate dependency on and contact with their ambient medium, aquatic organisms are uniquely revealing as indicators of pollutants. Fishes and aquatic invertebrates, such as Crustacea and mollusks, live in the relatively efficient solvent and carrier, water. Pollutants, either through run-off or fallout,

enter the aquatic portion of the environment and there become sequestered or stored to later become available for human exposure via various routes such as drinking water, seafood, or direct water contact. Therefore, aquatic systems and organisms are too important to ignore because of their value as bioindicators in environmental health, particularly in regard to chemical agents.

To date, two major characteristics of certain aquatic organisms have made them valuable bioindicators. The first is their variable, but relatively efficient ability to accumulate or concentrate pollutants over time. This phenomenon, called "bioconcentration," is characterized by increases in concentration of pollutant in the organisms's tissues above ambient concentration. Another related phenomenon, "biomagnification," results in increased pollutant concentrations at various trophic levels because of enhanced exposure to higher-than-ambient concentrations accumulated in the tissues of prey organisms in the food web or food chain.

Several examples of accumulation of polychlorinated biphenyls, polycyclic aromatic hydrocarbons and pesticides in various fishes and shellfishes may be used to demonstrate the relative usefulness and limits of this phenomenon in utilizing specific species[1,2,3] and different tissues[3] of aquatic organisms to monitor the environment for the presence of pollutants.

The second characteristic associated with aquatic organisms that lends potential usefulness to them as bioindicators is their capacity to respond to many pollutants in terms of physiological and pathological changes. This biological response category is very useful because many aquatic organisms in their biologic responses to pollutants may be predictors or models of responses in higher animals, such as mammals, including man. In the study of phenomenological areas, such as mutagenesis, teratogenesis and especially carcinogenesis, aquatic animals are promising models.[4]

Examples of the effects of Kepone,[5] trifluralin,[6] and cadmium[7] on fishes and invertebrates are available to demonstrate the quality of responses, particularly sublethal responses, of certain aquatic animals to pollutants.

Future research in utilization of aquatic animals as indicators of environmental exposures to pollutants should include:

1) Short-term and long-term laboratory tests to determine specific biologic response profiles of aquatic species to carcinogens and teratogens

2) Aquatic animal genetic-assay systems for use in screening potential pollutant compounds for effects (mutagenicity), and risks (population effects)

3) Epizootiological studies of specific fish and shellfish populations to determine the correlation between disease and pollutant activity (field studies of the "real world").

Studies are already underway in most of these areas, but they should be continued, expanded in some cases, and improved to yield maximum information on aquatic animals as indicators of pollution. In the future, emphasis should be placed on the relationships that may exist among selected pollutants, aquatic animal, or wildlife health in general, and human health.

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